

STANFORD H. SMITH

# Report of the Conference on the Upper Great Lakes

GREAT LAKES RESEARCH INSTITUTE  
UNIVERSITY OF MICHIGAN



*University of Michigan Biological Station*

*Douglas Lake — July 29-31, 1953*

CONFERENCE ON THE UPPER GREAT LAKES

Sponsored by the  
GREAT LAKES RESEARCH INSTITUTE  
UNIVERSITY of MICHIGAN

Auspices of the Summer Session

University of Michigan Biological Station

Douglas Lake

July 29-31, 1953

## PREFACE

The Conference on the Upper Great Lakes, sponsored by the Great Lakes Research Institute, was held at the University of Michigan Biological Station, Douglas Lake, Cheboygan Co., Mich., from July 29-31, 1953.

The primary purpose of the Conference was to bring together a representative group of persons actively engaged in research on the Upper Great Lakes (Huron, Michigan and Superior) for an exchange of ideas as to the present status and future objectives of basic scientific research on these Lakes. Also invited to attend were individuals who, because of their special knowledge of other Great Lakes areas or of modern techniques of deep water study, would undoubtedly contribute greatly to any discussion of Great Lakes problems.

A secondary objective was to determine how the Institute could function most effectively in relation to other established agencies in stimulating and furthering work on the Lakes.

This report includes the summaries of the topics discussed, recommendations, and suggestions as to how the Great Lakes Research Institute might serve in carrying forward long time scientific investigations of the Great Lakes.

Since the Great Lakes system is a vast one it was considered that for the purposes of a first conference the Institute might confine itself to a discussion of Lakes Huron, Michigan and Superior. It recognized, however, that to a considerable degree all of the Great Lakes presented similar problems and opportunities for investigation.

The wide interest expressed in the Conference and the splendid response of individuals has demonstrated beyond question the value of such a meeting. It is proposed, therefore, that in 1954 the Institute will sponsor a similar conference which will deal with problems common to all the Great Lakes. Every

effort will be made not only to secure representation from interested agencies in all the Great Lakes region but also to widen the scope of the research areas to be considered (to include, for example, the important field of Sanitary Engineering).

It is a pleasure to thank the Director of the Summer Session for funds covering the expenses of the Conference. It is a further pleasure to acknowledge the very great assistance of the Director, Alfred H. Stockard, and Staff of the Biological Station in promoting the success of the Conference and for their warm hospitality. Great credit is due the members of the Conference and the moderators for the efficient manner in which their business was conducted.

It is my pleasure to present herewith the report of the Conference.

F. K. Sparrow

Conference Organizer

## INTRODUCTION

The Conference on the Upper Great Lakes was divided into the following sections:

Hydrology and Meteorology

Geology

Limnology

Fisheries

These sections first met individually. Joint sessions of Hydrology, Meteorology and Geology, and Limnology and Fisheries were then held. Reports were prepared at the end of each of these meetings which served as a basis for discussion in subsequent sessions. Both individual and joint section reports were presented at the final meeting of the entire Conference.

Included here are the reports of the sections on Hydrology and Meteorology, Geology, and a combined report of the Limnology and Fisheries sections.

The following persons participated in the Conference.

### Hydrology and Meteorology

Arlington D. Ash, District Engineer, U. S. Geological Survey.

Ernest F. Brater, Professor of Hydraulic Engineering, University of Michigan and Council, Great Lakes Research Institute.

Dale W. Granger, Michigan Water Resources Commission.

E. Wendell Hewson, Research Physicist, Engineering Research Institute, Lecturer In Meteorology, Department of Civil Engineering, University of Michigan.

W. T. Laidly, Chief Technical Assistant, U. S. Lake Survey, Corps of Engineers, U. S. Army.

W. W. Oak, Meteorologist-In-Charge, U. S. Weather Bureau, Detroit.

### Geology

Stannard G. Bergquist, Chairman, Department of Geology and Geography, Michigan State College.

J. A. Ferris, Staff Engineer, U. S. Geological Survey.

John L. Hough, Associate Professor of Geology, University of Illinois.

Howard J. Pincus, Associate Professor of Geology, Ohio State University.

John G. Rulison, Geological Survey Division, Michigan State Department of Conservation.

F. T. Thwaites, Professor of Geology, University of Wisconsin.

James T. Wilson, Associate Professor of Geology, University of Michigan, and Chairman of the Council, Great Lakes Research Institute.

James H. Zumberge, Assistant Professor of Geology, University of Michigan.

#### Limnology

John C. Ayers, Associate Professor of Oceanography, Cornell University.

Clifford Berg, Associate Professor of Limnology, Cornell University.

David C. Chandler, Professor of Limnology, University of Michigan.

Frank E. Eggleton, Professor of Zoology, University of Michigan.

Arthur D. Hasler, Professor of Zoology, University of Wisconsin.

#### Fisheries

Robert C. Ball, Professor of Zoology, Michigan State College.

John Budd, Department of Lands and Forests, Province of Ontario.

C. H. D. Clarke, Assistant to the Chief, Fish and Wildlife Division, Department of Lands and Forests, Province of Ontario.

Charles W. Creaser, Chairman, Department of Zoology, Wayne University, and U. of M. Biological Station.

Frederick E. J. Fry, Professor of Zoology, University of Toronto and Director of South Bay, Lake Huron, Fisheries Research Station.

Ralph Hile, Fishery Research Biologist, U. S. Fish and Wildlife Service, and Council, Great Lakes Research Institute.

Robert F. Inger, Assistant Curator of Fishes, Chicago Museum of Natural History.

Karl F. Lagler, Chairman, Department of Fisheries, School of Natural Resources, University of Michigan and Secretary, Great Lakes Research Institute.

Thomas H. Langlois, Director, Franz Theodore Stone Institute of Hydrobiology, Ohio State University, Put-in-Bay, Ohio.

Justin W. Leonard, Research Administrator, Michigan Department of Conservation.

Kenneth Loftus, Fisheries Biologist, Department of Lands and Forests, Province of Ontario.

James W. Moffett, Chief, Great Lakes Fishery Investigation, U. S. Fish and Wildlife Service.

Lloyd L. Smith, Jr., Associate Professor of Zoology, University of Minnesota.

J. Murray Spiers, Secretary, Great Lakes Fisheries Research Board of Canada.

John Van Oosten, Fishery Research Biologist, U. S. Fish and Wildlife Service.

Loren P. Woods, Curator of Fishes, Chicago Museum of Natural History.

Burt Robb, Director of the Michigan State Waterways Commission and W. J. K. Harkness, Chief, Fish and Wildlife Division, Department of Lands and Forests, Province of Ontario, were prevented by emergencies from attending. Dr. Harkness was represented, however, by C. H. D. Clarke, Assistant to the Chief, Division of Fish and Wildlife, and K. Loftus, Fisheries Biologist. It was a particular pleasure to have present Dr. J. Murray Spiers, Secretary of the newly formed Provincial-Dominion Great Lakes Fisheries Research Board of Canada.

REPORTS OF SECTIONS

## HYDROLOGY AND METEOROLOGY SECTION

Ernest F. Brater, Moderator

The group began its discussion by tabulating the types of basic data which are needed for hydrological and meteorological research. Much of this information is also needed by investigators in the fields of geology, limnology and fisheries. The persons comprising this section included representatives from the various federal and state agencies that are responsible for collecting the data. Consequently, up-to-date information as to the extent of the data of each type being collected was provided by various members of the group. This portion of the discussion is summarized by the following two tabulations. First, the various types of data are tabulated with pertinent notations, then the various investigative programs are listed under the headings of the agencies doing the work.

### Types of Basic Data

1. Stream Flow. An extensive program is in progress under a cooperative program between the U. S. Geological Survey and state agencies. More data are needed, however, on small streams.
2. Precipitation. The U. S. Weather Bureau and certain local agencies are collecting data. More short period records, however, are needed.
3. Lake Levels. Records are being collected by the U. S. Lake Survey, Corps of Engineers.
4. Evaporation. Only meager records are now available. Plans and money are available for an intensive study on one Lake by the U. S. Lake Survey, Corps of Engineers.
5. Wind. Records are being taken by the U. S. Weather Bureau. Information on vertical velocity, variation and records over the Lakes are needed.
6. Humidity. Records are available from the U. S. Weather Bureau.
7. Air Temperature. Records are available from the U. S. Weather Bureau.
8. Water Temperature. Some records are being taken for the U. S. Weather Bureau. These, however, are not published.

9. Ground Water Levels. Records being collected by the U. S. Geological Survey and state agencies. More detailed records at rivers and lake shores are needed.
10. Soil Moisture. No information is now being collected.
11. Frost Penetration. There is some unpublished information available, but more is needed.
12. Date of First Ice Formation. Some information is available from the U. S. Weather Bureau.
13. Sediment Load of Streams. Little information is available. More is needed.
14. Plant Transpiration. Information is needed.
15. Nature of Shore and Near Shore Materials. Information is needed.
16. Ground and Surface Water Quality. Some information is being collected by the U. S. Geological Survey and state agencies. More, however, is needed.

Types of Data Being Collected and Studies Being  
Made by Various Agencies

Lake Survey and Corps of Engineers Studies

1. New compilation of revised precipitation data on land and water surfaces in the Great Lakes.
2. Variations in Great Lakes levels.
3. Great Lakes regulation studies (preliminary report).
4. Evaporation studies (preliminary stages).
5. Discharge data on connecting and outflow rivers of the Great Lakes.
6. Studies of short period fluctuations of Great Lakes levels.
7. Statistical analysis of annual highs and lows in Lake levels.
8. Maintenance of lake level gages on the Great Lakes System.
9. Major storms of the United States.
10. Wave height measurements at Bay City and Monroe, Michigan.
11. Hydrography in St. Mary's River.

U. S. Geological Survey

1. Continued stream gauging program on all major streams of the Great Lakes Basin. The runoff is now being measured from 65% of the land area of Michigan. Another 10% is proposed.

2. Limited inland lakes levels record program.
3. Compilation and publication of stream discharge data.
4. Special stream flow studies in cooperation with Stream Improvement Section of the Conservation Department. Improved land use, soil conservation, temperature records, improved fish habitat are all part of the overall plan.
5. Ground water program and studies of specific problem areas.
6. Ground water levels observation program.
7. Bedrock topography program.

#### U. S. Weather Bureau

1. Continuous program of observations, collection and publication of meteorological data.
2. Special evaporation studies at a few selected sites.
3. Great Lakes water temperatures taken daily, in addition to mid-lake temperatures (Michigan) available at Detroit. Some search of the records is, however, necessary.

#### Michigan Water Resources Commission

1. Correlation of the water resource problem of the state with all interested agencies.
2. Studies and "watch dog" activities necessary to a sound legislative program.
3. Beach erosion studies and reports.
4. Cooperative "Shore Processes" study at three sites along Lake Michigan shore with Corps of Engineers.
5. Water quality cooperative program.

#### University of Michigan Lake Hydraulics Laboratory

1. Three research publications on beach erosion processes and protection methods have been prepared in cooperation with the Michigan Department of Conservation and the Michigan Water Resources Commission. The last of these, "Low Cost Shore Protection for the Great Lakes", is now receiving extensive circulation among lake shore property owners.
2. Six technical reports on harbor design and related problems have been prepared as the result of model studies in the laboratory.

## Lake Erie Geological Research Program

Information related to shore processes is available.

Various Power Companies in the Lake States using water power collect and have available many hydrological data.

### Problems Urgently Needing Investigation

The second portion of the meeting of the Hydrology and Meteorology Section was devoted to a tabulation and discussion of specific problems upon which research is urgently needed. These are listed below in two groups, the first hydrological and meteorological; the second, beach erosion problems.

#### Hydrological and Meteorological Problems

1. Monthly and annual evaporation from the Great Lakes.
2. Evaporational and transpirational losses on watersheds tributary to the Lakes.
3. Magnitude of ground water inflow to the Lakes.
4. Relation between precipitation and other meteorological factors and the levels of the Lakes.
5. Sediment load of streams tributary to the Lakes.
6. Evaluation of the damage or benefits resulting from discharge of the sediment load of streams into the Lakes.
7. Effect of land use practices on water losses, runoff and sediment load.
8. The effect of frozen ground on infiltration capacity.
9. The effect of the Great Lakes on weather.
10. A study of currents in the Great Lakes, including density and turbidity currents. Study by aerial photography as one method. Attention was brought to pollution and water supply and to currents at depths as well as surface.
11. Determination of precipitation by radar.

#### Beach Erosion Problems

1. Effect of long jetties on beach erosion.
2. Height of fore-shore beach necessary to provide protection against waves at various heights.

3. Determination of the most effective height, length and spacing of groins.
4. Effectiveness of groins of various degrees of permeability.
5. Determination of the relation between fetch, wind duration, and wind velocity on wave height and wave period on the Lakes.
6. A study of the forces and movements induced by waves of various characteristics on structures of various shapes and types.
7. The effect of ice on shore structure and beaches.
8. The effect of floating debris on shore processes and shore structures.
9. Surveys of potential and actual sources of beach building materials and directions, rates and methods of sediment transport.
10. Beach erosion report from Canada.

## GEOLOGY SECTION

John L. Hough, Moderator

The Geology Section endeavored first, to list in broad, general categories the geologic problems related to the Upper Great Lakes, then, to select those problems which are most urgently in need of study. In selecting the latter, those were chosen which were most fundamental in relation to other geological studies and which might be expected to provide basic information to investigators in other fields. Further, only those problems were selected which could conceivably be attacked during the next few years with such equipment and facilities as would probably be available.

An assessment was made of the major research facilities available, and those needed.

The findings of the Section are as follows:

### 1. Geologic Problems of the Upper Great Lakes

- a. Bed rock topography and its relation to the topography of the Lake basins. In particular, information is needed on the depth to bed rock in certain critical areas, such as possible former drainage channels.
- b. Bed rock type in relation to topography of the Lake basins. F. T. Thwaites has published an article (Papers of the Michigan Academy of Science, Arts and Letters 33: 243-251. 1949) concerned with this aspect of Lake Michigan.
- c. Pre-glacial shaping of the Great Lakes basins. The U. S. Lake Survey, Corps of Engineers, has a new program of cross lake soundings.
- d. Glacial shaping of the Great Lakes basins.
- e. Post-glacial modification of the Great Lakes basins (including present-day shore processes).

- f. Late glacial and post-glacial history of the Great Lakes and their connecting channels.
- g. Effect of Great Lakes sedimentation in inter-glacial times on the composition of tills in the Great Lakes region.
- h. Characteristics of recent Great Lakes sediments, and of their environments.
- i. The fossil record in the Great Lakes sediments, and its possible indication of a climatic record or of the paleolimnology of the Lakes.

## 2. The Most Urgent Fundamental Problems

- a. Preparation of topographic maps of the Great Lakes basins, based on latest sounding data. These will be of immediate use in the planning and guiding of field programs of geologic and other investigations. In addition, they will be of use in the interpretation of bed rock structure, the shaping of the Great Lakes basins, the general history of the Great Lakes, and in various practical problems.
- b. Preparation of maps showing distribution of bottom types. These should show only the known distribution, rather than an extrapolation of the meager data available. They will be of use in planning and guiding of future work by geologists and others.
- c. Study of post-glacial sediments and their relationship to the Lake environment and to source areas of the sediments. Various standard determinations of texture, composition, and some of the mass properties should be made. Aspects of the environment of particular interest are the following: water temperatures, currents, chemistry of the waters. Information obtained from these studies will be applicable to the synthesis of the later part of the geologic history of the Great Lakes.

- d. More samples are needed for radiocarbon dating, particularly in the Mankato-Nipissing interval.
- e. Study of well borings on shore, to provide more information on the glacial drift and sediments of the region. The following specific recommendations are made:

- (1) Water well driller's logs and samples should be filed with the State Geological Survey. A bill requiring this is to be introduced at the next session of the Michigan Legislature. Similar laws are in effect in most other states bordering on the Upper Great Lakes.
- (2) Arrangements should be made for the study of wells in areas of deep drift. Perhaps, during the drilling of oil wells in such areas in Michigan, arrangements could be made for the coving of the drift and the study of the cores by Pleistocene specialists.

- f. More rigid control should be exercised in the issuance of sand dredging permits to avoid starvation of beaches.
- g. A survey of literature of the Great Lakes is needed for the preparation of a bibliography.

### 3. Research Facilities

The following research facilities are possibly available for some degree of cooperative use:

#### Boats:

Cisco, U. S. Fish and Wildlife Service  
Williams, U. S. Lake Survey, Corps of Engineers  
S. E. 1, Ohio State Department of Conservation  
Michigan Department of Conservation, small boats and patrol boat  
U. S. Coast Guard vessels  
Illinois State Waterways Commission vessel

#### Shore facilities:

University of Michigan Biological Station  
Michigan Department of Conservation shore stations

U. S. Fish and Wildlife Service shore stations  
Ohio Division of Wildlife Station  
Franz Theodore Stone Laboratory  
U. S. Coast Guard Stations

Facilities needed: The principal item needed is a boat, with adequate winch, radar, fathometer, and gyro compass, and funds for operation of the boat.

In conclusion, the Geology Section agreed that the minimum requirements for a program of research on the Upper Great Lakes is a central organization which would act as a coordinating agency and would provide a boat of adequate size with facilities specified.

## JOINT REPORT OF LIMNOLOGY and FISHERIES SECTIONS

Moderators: John C. Ayers, Limnology  
Karl F. Lagler, Fisheries

The part of the current conference of the Great Lakes Research Institute dealing with Limnology and Fisheries was limited to a discussion of the Upper Lakes, i.e. Lakes Huron, Michigan and Superior. It was recognized that future conferences may comprehend any or all of the Great Lakes, depending upon expressed interest of workers in the various areas. It was also recognized, at least from the point of view of the aquatic biologist, that the existing information on all of the Great Lakes is incomplete geographically, biologically, chemically, physically, hydrographically and geologically. Toward the end of filling the many existing gaps in knowledge, future conferences similar to the present one and heightened activity of the Great Lakes Research Institute and related organizations were repeatedly urged.

### I. Historical Basis for Research on Great Lakes Problems

A considerable body of knowledge exists, dealing with the limnology and fisheries of the Great Lakes. This information is found in published and unpublished reports. Bibliographies of the published material have been assembled at Ann Arbor by Dr. John Van Oosten and at the University of Toronto by Dr. J. Murray Speirs. It was suggested that these bibliographies be made available in some form for distribution to interested investigators.

In addition, many unpublished reports and a considerable quantity of data are in the possession of the U. S. Fish and Wildlife Service, U. S. Weather Bureau, U. S. Lake Survey, and U. S. Geological Survey; the comparable agencies of Canada, the Province of Ontario, the states and municipalities bordering the Great Lakes, and the Universities of Ohio, Michigan, Toronto and Western Ontario.

It was the unanimous opinion of the Conference that an extremely valuable function of the Great Lakes Research Institute could be the compilation of a complete Great Lakes bibliography, including listings of unpublished data and of research in progress. This bibliography should be available from the Institute and distributed to anyone interested. The Institute should further act as a central clearing house for subsequently acquired knowledge. In these ways, considerable impetus and avoidance of duplicate effort would be provided to investigational activity in the region.

From past studies it was evident that the most productive researches have been obtained by cooperative effort of federal, state, international and industrial agencies, and by long-term programs. Much of the financial support has been obtained by pointing out practical values to industry, government and other supporting agencies.

## II. Current Investigations

Projects currently in progress dealing with various phases of the aquatic biology of the Great Lakes are very numerous. These projects deal mostly with:

### Limnology

1. Temperature ✓
2. Plankton ✓
3. Bottom fauna ✓ *life history & inventory*
4. Water chemistry ✓
5. Bottom sediments

### Fisheries

- ✓ 1. Life histories and ecology of individual fish species
2. Sea lamprey life history and control
- ✓ 3. Exploration of possibilities for additional sporting and/or commercial use of certain fishes
4. Development of management procedures for anadromous species

5. Production of sport and commercial fishes

6. Racial analyses

7. Factors of abundance

8. Regulation

9. Pollution

It was established that a service agency such as the Great Lakes Research Institute could do much to stimulate and effect exchange of information, use of cooperative effort, and integration of findings.

### III. Investigational Opportunities, Needs and Plans

Opportunities and needs for research on Great Lakes problems were recognized as being boundless. A need exists for the integration of current investigations with those of the past, but the outstanding need is for more information on all aspects of Great Lakes biology. Administrators are continually vexed by lack of facts on which to establish policies for managing the aquatic resources of the region.

For the most part, the investigational plans which were reported were extensions or continuations of projects in progress. New developments of note, however, were cited and are described below.

The Canadian Federal Government has recently entered the hydrobiological and fishery research fields in the Great Lakes and is cooperating with the Provincial Government of Ontario in a new Dominion-Provincial Committee for Research on the Great Lakes. Plans are being formulated currently for several practical approaches to existing problems.

None of the Great Lakes, not even a local area within any one of them, is so completely known as not to require further study. Lakes Huron and Superior, in particular, are very poorly known limnologically. Northern Lake Huron is an example of a region most apt to richly reward any study. A survey of the physical characteristics of this area would produce, for a limited expenditure

of time and money, a framework of knowledge useful in many fields for the planning of researches. It was considered that such a survey could provide, relatively quickly, evidence of the determination of the Institute to carry on a program leading to an understanding of the Great Lakes system. This could also be a core of achievement to which reference might be made in case the Institute should require additional financial support. Toward this end there was preliminary planning for a cooperative project involving the Province of Ontario, the U. S. Fish and Wildlife Service, and the University of Michigan's Biological Station and Campus Departments. These agencies could put on Lake Huron about ten vessels for a simultaneous appraisal of temperature and other physical conditions throughout the total expanse of the Lake on, possibly, each of three days spaced through next summer. It was suggested that dates approximating June 15, July 15 and August 15 would be suitable. In addition, specific plans were outlined by J. C. Ayers and D. C. Chandler for a continuous study of currents, temperature and distribution of bottom sediments in Northern Lake Huron during June, July and August of 1954. This project will involve the cooperative efforts of various University units, with headquarters at the University of Michigan Biological Station. Its field aspects will be supervised by an oceanographer.

It appeared to the Conference that southern Lake Huron was the second most fruitful area for a physical survey, and that such study would be highly desirable.

#### IV. Means for Stimulating and Expediting Research on the Great Lakes

The Great Lakes Research Institute could assume the needed leadership in any or all of the following important areas and opportunities:

1. Provide added public education, for example, through popularization of researches and by systematic releases to trade journals, etc.
2. Promote improvement and increase of research facilities. A directory of laboratories, vessels, cruise itineraries, etc., should be made and distributed.

3. Establish fellowships and encourage personnel exchanges.
4. Create informal standing committees in area studies -- geographical or subject matter -- and circulate more widely the reports of existing (viz. sea lamprey, lake trout, etc.) and future committees.
5. Provide added facilities for publication.
6. Catalog existing publication outlets for workers in aquatic biology of the Great Lakes.
7. Compile and circulate information on researches in progress.
8. Provide a repository for records and collections and catalog present repositories and disposal of records and collections.
9. Organize an approach to sources of financial support to achieve:
  - a. A core endowment for continuing studies
  - b. Support for individual projects
  - c. Firmness in Federal, Provincial and State investigational budgets.
10. Improve professional standards and rewards.
11. Move to standardize research procedures within the framework of the following principles and suggestions:
  - a. Selection of units should be based primarily on ready comprehensibility without preliminary mental conversion.
  - b. Mixed systems of units are not necessarily objectionable.
  - c. In publications, the "key" information should be given in both metric and English systems.

## V. Standardization of Procedures

### Standard Survey

In the interests of comparability of data, and because knowledge of the physical and chemical environment is fundamental to many different kinds of studies, the conference ventured to outline its conception of a "standard survey". It is believed that surveys in the Great Lakes should include at least the major portions of the parameters listed. Data of other types desired by other fields of study should be dovetailed with this standard survey.

The standard survey is designed to provide minimum environmental data for all aquatic studies. It consists of:

- ✓ 1. Bathymetry by fathometer.
- ? 2. Bottom sediment type (plus sample for mechanical analysis).

- ✓ 3. Temperature to bottom by use of bathythermograph.
- ✓ 4. Surface temperature.
- ✓ 5. Light penetration by use of photometer.
6. Turbidity (with bottled sample for suspended and dissolved material).
7. Water samples for chemical analysis; oxygen, total phosphorus, total nitrogen, alkalinity, pH, calcium, other minerals. *conduct*
- ✓ 8. Surface currents: when possible, drift bottles should be set out.
9. Plankton: when possible, make exploratory surface tows.

#### Miscellaneous Field and Laboratory Procedures

Considerations of these sections concerning measures and standardization in technique and usage in field and laboratory procedures and in publication are as follows:

1. Hydrographic and other limnological measurements:
  - ✓ Depths -- in deeper waters, fathoms
  - ✓ -- in shallow water (less than 10 fathoms), feet
- ✓ 2. Temperatures: C°
- ✓ 3. Uniform size of photographic print on B-T charts for necessary exchange, 3" x 5".
- ✓ 4. Areas: English system
- ✓ 5. Distance: Statute miles
6. Productivity: Bottom fauna -- grams per square meter, pounds per acre
  - ✓ Fish -- pounds per acre
- ✓ 7. Fathometer tracing: Continuous on all cruises
- ✓ 8. Physical and chemical determinations: realizing that new methods have superseded some of those given in "Standard Methods," and desiring comparability of data, it is recommended that analyses be made by the methods of "Standard Methods" or by more recent ones.
- ✓ 9. Measurements and age of fish: English system for both lengths and weights, decimal fractions; length to be measured--

uniformity highly desirable but presently difficult by reason of provisions in laws on size limits. Suggest uniform adoption of total length, both in scientific investigations and in the law, tip of head to tip of tail, lobes compressed.

- ✓ 10. Age groups of fish: 0, I, II -- in terms of completed annuli, provided that age changes as of January 1.
- ✓ 11. Year classes of fish: Calendar year of origin -- fall-spawning salmonoids credited to year of spring of hatching.
- ✓ 12. IBM tabulations: For data on all hydrobiological fields susceptible to IBM analysis and likely to be interchanged between agencies, use uniform coding systems.
- ✓ 13. Fishing statistics: Retain present uniform method of reporting and analysis.
- ✓ 14. Names of fishes: Common names as prescribed by American Fisheries Society.

